

129 Shortened SF₆ MBW is a repeatable and sensitive test in adults and children with CF

D. Hannon¹, I. Bradbury², J.M. Bradley³, A. Reid⁴, N.J. Bell⁵, J.S. Elborn¹, K. O'Neill¹. ¹Centre for Infection & Immunity, Queen's University Belfast, Belfast, United Kingdom; ²Frontier Science Ltd, Scotland, United Kingdom; ³Centre for Health and Rehabilitation Technologies (CHART), University of Ulster, Belfast, United Kingdom; ⁴Belfast Health and Social Care Trust, Belfast, United Kingdom; ⁵Respiratory Medicine Department, Bristol Royal Infirmary, Bristol, United Kingdom

Introduction: Lung Clearance Index (LCI) derived from SF₆ multiple breath washout (MBW) is a sensitive measure of lung disease. However it can be time-consuming, limiting its clinical use.

Aim: To compare the repeatability and sensitivity of LCI until 1/40th of starting concentration (LCI₄₀) to a shorter version of LCI until 1/20th of starting concentration (LCI₂₀).

Methods: Triplicate MBW test data from 30 stable CF patients and 30 healthy controls were selected from a larger prospective study. MBW tests were performed using 0.2% SF₆ and a modified InnocoTM. LCI₄₀ and LCI₂₀ were calculated using SimpleWashout software. Repeatability was assessed using coefficient of variation (CV%). The proportion of CF patients with abnormal results was compared. LCI normal limits were determined from control mean+2SD. Receiver operating characteristic (ROC) curve statistics were calculated (1.0=accurate test).

Results: CV% of LCI₄₀ and LCI₂₀ was comparable and not significantly different to controls (Table 1). The sensitivity of LCI₄₀, LCI₂₀ and FEV₁ was 67%, 63% and 47% respectively. Area under the ROC curve (95% CI) for LCI₄₀, LCI₂₀ and FEV₁ were 0.87 (0.78–0.96), 0.87 (0.77–0.96) and 0.73 (0.60–0.86) respectively.

Table 1. Summary of CF and control data

	CF (n=30)	Control (n=30)	p-value
Mean (SD) age	20.7 (11.1)	20.8 (10.7)	0.93
Mean (SD) LCI ₄₀	8.9 (2.4)	6.4 (0.5)	<0.0001
CV%	5.2 (2.8)	4.3 (2.0)	0.20
Mean (SD) LCI ₂₀	6.6 (1.2)	5.2 (0.4)	<0.0001
CV%	5.7 (3.4)	4.6 (2.3)	0.26

Conclusions: LCI₂₀ is a repeatable and sensitive test that is shorter than LCI₄₀, offering a more feasible clinical measure.

Funded by a US–Ireland Project Partnership Grant.

130 Enhanced photoacoustic gas analyser (Innoco^r) for multiple breath washout. Improvements to analyser response time maintains accuracy at fast ventilation rates, and produces a system that meets all washout technology performance targets

A. Horsley^{1,2}, K. Macleod³, R. Gupta⁴, N. Goddard⁴, N.J. Bell⁵. ¹University of Manchester, Institute of Inflammation and Repair, Manchester, United Kingdom; ²Manchester Adult Cystic Fibrosis Centre, Manchester, United Kingdom; ³Great Ormond Street Hospital, London, United Kingdom; ⁴University of Manchester, School of Chemical Engineering and Analytical Science, Manchester, United Kingdom; ⁵University Hospitals Bristol NHS Foundation Trust, Department of Respiratory Medicine, Bristol, United Kingdom

Objectives: The Innoco^r device contains a highly sensitive photoacoustic analyser which allows multiple breath washout (MBW) measurements using very low concentrations of the tracer gas SF₆. Previously, use in smaller subjects has been restricted by the need for an analyser response time <100 ms to ensure accurate estimation of lung volumes at rapid ventilation rates. Here we report the effect of response time improvements.

Methods: A series of previously reported and novel enhancements were made to the analyser to produce a clinically practical system with a reduced response time. An enhanced lung model was constructed delivering highly accurate ventilation rates and volumes. This was used to assess *in vitro* accuracy of volume calculation, and the effects of flow and gas signal alignment.

Results: 10–90% rise time was reduced from 154 to 88ms. In an adult/child lung model, accuracy of volume calculation was –0.9 to 2.9% for all measurements, including at a ventilation rate of 30/min and lung volume 0.5 L; for the un-enhanced system, accuracy deteriorated at higher ventilation rates and smaller lung volumes. In a separate small volume lung model (ventilation rate 60/min, lung volume 250 ml, tidal volume 100 ml), mean accuracy of volume calculation for the enhanced system was minus 0.95% (range –3.8 to 2.0%).

Conclusion: The Innoco^r analyser can be enhanced to reliably generate highly accurate lung volume measurements down at volumes as low as those simulating infant lung settings. Signal alignment is a critical factor. With these enhancements, Innoco^r achieves all of the recent technical recommendations for MBW apparatus, including those for accuracy in infant settings.

131 Multiple breath nitrogen washout in healthy children and adults: a comparison of two commercially available devices

W. Poncin¹, A.-S. Aubriot¹, P. Lebecque¹. ¹Cliniques Universitaires Saint-Luc, University of Louvain, Cystic Fibrosis Unit, Brussels, Belgium

Background: Multiple breath nitrogen washout (MBWN2) is a promising tool in pediatric pulmonology. Data comparing recent commercially available devices are lacking.

Objective: To compare the results obtained from 2 such devices in healthy children and adults.

Methods: Healthy subjects were recruited to perform MBWN2 tests in duplicate using two devices (EasyOne Pro, NDD, Switzerland – Exhalyzer D, EcoMedics, Switzerland), in random order on the same session. Agreement between devices was assessed by Bland-Altman plot. In a subset of adults, FRC was also measured using helium dilution (FRC He).

Results: Acceptable values were obtained with each device in all subjects (51 adults: 21–58 y, 41 children: 5–17 y). Both devices were considered equally convenient by children and adults. Using a given apparatus, LCI values were similar in adults and children, which allowed to pool the data (n=92). On average, LCI NDD was consistently lower than LCI EM (6.54±0.57 vs 6.94±0.42, p<0.001; mean difference: –0.40, 95% CI: –1.59 to 0.79). EM yielded a narrower range of normal values (p=0.04). The intraindividual CV was lower using EM than using NDD (2.9±2.6% vs 5.5±3.7%, p<0.001). FRC NDD was lower than FRC EM (2.04±0.94 L vs 2.7±1.28 L; p<0.001). FRC He was measured in 11 adults and corresponded to 100% (±6) of FRC EM and 81% (±7) of FRC NDD. When compared to FRC He, underestimation of FRC by NDD was significant (p<0.001).

Conclusion: In normal subjects, LCI and FRC obtained using current versions of the EasyOnePro or the EcoMedics are not interchangeable. EcoMedics yields more reproducible LCI values, a narrower range of normal values and more accurate FRC measurements.

132 Improving the feasibility of multiple-breath nitrogen washout in cystic fibrosis adults

W. Poncin¹, A.-S. Aubriot¹, P. Lebecque¹. ¹Cliniques Universitaires Saint-Luc, University of Louvain, Cystic Fibrosis Unit, Brussels, Belgium

Background: In CF, lung clearance index (LCI) measured by a multiple breath nitrogen washout (MBWN2) is time consuming in patients with advanced respiratory disease. Shortening the test would increase its feasibility.

Objective: To assess repeatability and diagnostic performance of LCI in CF adults, from two acceptable runs until 1/40th (LCI_{2.5}, conventional test), 1/25th (LCI₄) or 1/20th (LCI₅) of starting N₂ concentration.

Methods: Retrospective analysis of MBWN2 tests performed in duplicate in adults with CF, using the Exhalyzer D (Ecomedics, Switzerland). Time to complete 2 measurements + between resting time (i.e. 1.5× washout time), diagnostic performance and repeatability were assessed for LCI_{2.5}, LCI₄ and LCI₅.

Results: Data from 34 CF adults were analysed (15 M, median age: 24.5 y, IQR: 21–32; mean±SD FEV₁: 84.5±19.8% pr). Mean (SD) LCI_{2.5} was 13.73 (3.63). Corresponding values for LCI₄ and LCI₅ were 9.52 (2.29) and 8.14 (1.83) respectively. Compared to LCI_{2.5}, repeatability of LCI₄ and LCI₅ were similar, but only the former had similar diagnostic performance and a predictive value (R²) for LCI_{2.5} >0.9 (R²=0.92). Mean time needed to complete 2 LCI₄ measurements was 9.9 min vs 15.6 min for LCI_{2.5} (p<0.001, time saving: 38%). Restricting the analysis to the 6 patients with highest LCI (19.01±1.59; mean FEV₁: 76% pr, range: 62–96), mean session duration decreased from 21.3 to 11.7 min (time saving: 45%).

Conclusion: In this study, LCI₄ appears to be a reliable and more feasible test in CF patients with moderate to severe lung disease.

Supported by the Belgian CF Association.